Biologists and Graph Interpretation Network

Agents of change: Determining effects of pollution on marine environments through data interpretation

A BioGraphI Module Lesson Guide for Instructors

Original Authors
Eilea Knotts, Ph.D., Department of Biological Sciences, University of South Carolina
Rachel Leads, Ph.D., Department of Fisheries and Wildlife, Michigan State University

Course Information
Department/Program: Biological Sciences
Level: Advanced
Course type: Lecture
Delivery mode: In-person
Students: Mixed majors, Biology and Marine Science
Number of students: 35
Estimated duration of activity: 45-65 minutes

Expected date or dates of implementation
November 2023

Purpose/Background
An in-class activity near the end of the marine ecology course on the impact of disturbance and pollution on marine ecosystems.

List of materials needed for the lesson

- Link to interview on YouTube (total running time, 18:53)
    - Youtube Link
- Link to Presentation Slides
    - 2_PresentationSlides_AgentsofChange
- Link to summative assessment
    - 3_SummativeAssessment_ AgentsofChange

About BioGraphI modules

This lesson is a BioGraphI module. BioGraphI modules address data literacy while fostering diversity in undergraduate biology classrooms. They are lessons about graph and data interpretation, featuring the scientific contributions of biologists who are members of historically excluded groups (HEGs). They include video interviews with these biologists, allowing students to hear directly from HEGs about their discoveries. For more information about how the BioGraphI project is advancing inclusion in biology and improving data literacy, visit our webpage.

Student Learning Objectives

The BioGraphI Student Learning Outcomes (LOs) describe what students can expect to gain by the end of the BioGraphI lesson. They are written in a format that can be shared directly with students.

Content learning objective(s)

1. Describe the ecological role of disturbances in marine environments.
2. Evaluate the anthropogenic impact of pollution on marine ecosystems and identify the consequences on the composition and diversity of biological communities.
3. Compare the connection between pollution and human-induced factors in different marine environments.

Quantitative learning objective(s)

4. Interpret graphs and/or data figures related to the concepts from this lesson.
5. Reflect on your perceptions about using graphs or figures in biology.

Diversity/equity/inclusion learning objective(s)

6. Reflect on your perceptions of people who do biology.
7. Compare your own interests and/or identities to those of people who do biology.

Assessments

To help the BioGraphI Project to measure the effectiveness of our modules in improving data literacy and fostering diversity in biology classrooms, we invite your students to participate in a voluntary, anonymous pre-/post-lesson survey (Geneseo IRB #202021048). This survey is designed as an opportunity for reflecting on the Quantitative and D/E/I learning objectives above and administered via LimeSurvey. Click Instructions for access to BioGraphI PrePost-Lesson Student Survey to request a survey to be set up for your students, at least 7 to 10 days in advance of your class meeting date.

See presentation slides for the formative 2_PresentationSlides_AgentsofChange assessment activities, and test questions document 3_SummativeAssessment_ AgentsofChange for multiple-choice, multiple-answer, fill-in-the-blank, and short answer exam questions.

Objective(s)	**Formative Assessment**	**Summative Assessments**
1	Poll Everywhere multiple-choice, polling, and ranking questions. Open-ended questions	Quiz: Short answer questions.
2	Concept maps, Think-Pair-Share group discussions	Quiz: Multiple-choice, fill-in-the-blank questions, Short answer questions.
3	Think-Pair-Share and open discussions	Quiz: Short answer questions.
4-5	Poll Everywhere multiple-choice, polling, and ranking questions. Open-ended questions BioGraphI Student Pre-Lesson Survey (link for instructions to access survey) Link to additional quantitative assessment tools that could be adapted	Quiz: Short answer questions. BioGraphI Student Post-Lesson Survey (link for instructions to access survey)
6-7	Open discussion, Written Reflection BioGraphI Student Pre-Lesson Survey (link for instructions to access survey)	BioGraphI Student Post-Lesson Survey (link for instructions to access survey)

Lesson context

Learning goals of unit

- Effectively communicate concepts related to marine pollution and its effect on marine ecological systems and apply that knowledge to proficiently articulate interpretations of data.

- Utilize critical thinking to evaluate evidence of ecological patterns and principles affecting marine ecosystems, distinguishing between relevant and irrelevant information to form well-informed conclusions.
- Evaluate the relationship between pollution of marine ecosystems and human-induced factors, demonstrating a nuanced understanding through critical assessment and thoughtful reflection.

Prerequisite skills or knowledge

- Conceptual background knowledge includes marine ecological principles and processes, patterns of biogeography and biodiversity, and the ecosystem services provided by marine systems.
- Skills practiced prior to this lesson include interpreting graphs and working in groups.

Preparation for lesson

- Assign reading from the textbook on the chapters of "Pollution, Disturbance, and Environmental Monitoring".
- Assign BioGraphI Student Pre-Lesson Survey as homework for students to complete before this in-class activity.

Lesson sequence

Each row of this table is a step of the activity. Column headings reveal what the instructor, interviewee, and students do at each step.

Information from instructor (live in-class)	**Information from scientist (within pre-recorded video interview)**	**Student follow-up or transition activity**
Prior to class, assign any preparation activities	N/A	Students complete reading assignments. Students complete homework/pre-lesson survey for BioGraphI project (combination of reflective writing prompts and closed-ended questions) • *Purpose*: prepare for class; LO 5 & 6 – Pre-lesson reflection on data literacy and perceptions of scientists
Provide	N/A	Students reflect and possibly share

information about identity and how it impacts student engagement in the classroom and their connection to science		their own perceptions of themselves and others. Purpose: LO 7 – warm-up and icebreaker
Ask question for think-pair-share	N/A	**Fundamental activity:** Brainstorm examples of ecological roles of disturbance ● *Purpose*: Warm-up and icebreaker, rewards creativity, normalizes errors (nearly impossible to be correct)
Introduce concepts of disturbance, pollution, and their impacts on marine systems	N/A	Purpose: LO 1-4 – provide context for information provided by the scientist **Fundamental activity:** Create concept maps of information as it is provided to show connection. ● *Purpose*: LO 1-3, warm up.
Plays first video segment	***Required interview Q.*** Orient us to this graph we've been working on. (What do these axes mean? How did you measure stuff? What do the units mean? *Vocabulary to incorporate:* types of graphs, units, independent (explanatory, predictor) variables, dependent (response) variables,	Hear background information and context of research from scientist Purpose: LO 4 and 5 – prepare to interpret graphs
Provide graph and formative assessment questions	N/A	**Fundamental activity:** Students interpret the graph with the correct axis labels. Infer the hypothesis that was studied. Evaluate whether the hypothesis was supported. Answer additional questions. ● *Purpose*: LO 2-4 - Check student understanding of the concepts and vocabulary

Plays next video segment	***Required interview Q.*** Tell me about the research that these data came from: scientist confirms the hypothesis inferred by & the interpretations made by students. - *Vocabulary to incorporate:* hypothesis, prediction, (explanatory, predictor) variables, dependent (response) variables, controlled (standardized) variables if applicable	Based on these results, what should the scientist investigate next? Share out. - *Purpose*: Transition to next steps; could be used to align Content LOs or LO 2A or B **Fundamental activity:** Think-Pair-Share about what students would explore next if they were the scientist. - *Purpose*: LO 2-5 - check student understanding of graph and evaluate other potential biological explanations and directions
Plays next video segment	***Required interview Q.*** Tell me about the research that these data came from: Describe the follow up experiment or potential follow up experiments ***Suggested interview Q.*** Explain why you used this model organism/system. What led you to conduct this specific study?	What's significant about these findings? - *Purpose*: LO 3
Pause to ask open discussion question	N/A	Closes the portion of the lesson focused on the research and LO 1-3
Play next video segments	***Required interview Qs*** **What kinds of scientific questions interest you the most?** **When and how did you know you wanted to be a scientist?** **Tell us about the paths that led you to your current job.** **What is it like being a scientist with a female identity?** **Tell me about a moment when you felt like you really belonged in the field of science.** *Strongly suggested Qs* What is a typical day like for you? How do you balance work with other interests? *Optional interview Qs* Where did you grow up, and what	*Purpose:* LO 6 & 7 - Identifying potential connections between students and scientist. Closes the in-class portion of the lesson.

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	was it like growing up there? What keeps you motivated to do research? What do you do if you have questions about how to analyze your data?	
Assign Homework	N/A	**Fundamental activity:** Written reflection on the student's perceptions of people who do biology. Students complete homework/post-lesson survey for BioGraphI project (combination of reflective writing prompts and closed-ended questions) ● *Purpose*: LO 4-7 – Post-lesson reflection on data literacy and perceptions of scientists

Alignment to Universal Design for Learning Guidelines

UDL Guideline	**Lesson Alignment**
Multiple means of Engagement	Recruiting interest: Students have the opportunity to generate their own questions for the scientist. Sustaining effort & persistence: Students interact with their peers one-on-one and in groups. Self-regulation: Students reflect on their dispositions and knowledge of scientists and graph interpretation before and after the lesson
Multiple means of Representation	Perception: Captions are provided on the interview video. Google Slides offers automatic captioning for presenter. Alt text for images provided in Google Slides. Comprehension: Background knowledge is activated via PollEverywhere questions.

	Discussion prompts guide information processing for graph interpretation.
Multiple means of Action and Expression	Expression & communication: Multiple types of media are used in the lesson (visual, audio, text). Physical Action: Varied means are used to prompt students (PollEverywhere questions, verbal processing via discussion, written reflection following lesson). Executive functions: Students think before talking to peers and sharing with the entire class. Students monitor their understanding with multiple-choice and true or false questions.

Implementation notes

Notes on our implementation

We implemented this lesson in an advanced biology and marine science cross-listed course at the University of South Carolina in November 2023. The class was delivered in-person in a lecture-style classroom. It had a smaller enrollment (~30 students). Due to the small size of the class, we had extensive small group discussions for each prompt and all groups had time to report on their group's discussion to the whole class before proceeding to the next slide. With this slow pace, the lesson took us 75 minutes to complete. Students engaged well with lesson activities that aligned with our Content, Quantitative, and DEI LOs.

In the classroom, students exhibited an enthusiasm for delving into the understanding of hidden identities and its consequential impact on the students' active engagement in the academic environment. Despite initial reservations about disclosing their own identities, the students readily embraced conversations surrounding the intricacies of student anonymity. Notably, a pivotal moment occurred when I, as the instructor, chose to share my own identities with the class. This disclosure fostered a sense of camaraderie and closeness. It provided a platform for students to reflect upon their preconceived notions about individuals in the field of biology, including themselves, as they drew comparisons between their own identities and mine. This shared experience created a more inclusive and connected learning environment, ultimately enhancing the overall dynamics of the classroom.

Lastly, the students in the class found a profound connection with the scientist when discussing the concept of imposter syndrome. As they explored the challenges and self-doubt that often accompany this phenomenon, many expressed a sense of relief and validation, feeling genuinely seen and understood. The scientist's candid acknowledgment of experiencing imposter syndrome created a powerful moment of camaraderie, breaking down barriers and fostering a shared understanding within the academic community. This revelation not only humanized the scientist but also resonated with the students, encouraging them to embrace their own vulnerabilities and recognize that imposter syndrome is a shared experience among individuals, even those in authoritative positions.

Suggestions for adaptation

Reducing length of lesson activities

Some instructors may wish to reduce the length of this lesson for their courses. To preserve the learning objectives of the lesson, we recommend eliminating one or more of the following activities (see Presentation Slides): Discussion Questions (Slides 34-36), Discussion Questions (Slides 39 and 40), Discussion Question (Slide 42), Discussion Question (Slide 44), and optional interview question slides (Slides 43 and 46).

Large enrollment courses

In a larger enrollment class, having undergraduate teaching assistants circulate the room during discussions would ensure most student groups stayed on task. Instructors of large classes could also randomly select two or three groups to report out after each small group discussion slide. Having student groups record discussion points up on the whiteboard or using PollEverywhere's open answer submission might also help keep student groups on task.

Online courses

In a synchronous online course, using the breakout room feature would allow for discussion. You can also use PollEverywhere's open answer submission or a Microsoft Forms for the breakout rooms to record their thoughts/notes on each discussion prompt as the lesson progressed. For the Microsoft form, be sure it contains only the discussion prompts (no answers). By numbering breakout rooms, instructors can keep track of which rooms are participating and which are not.

In an asynchronous online course, we suggest using conditional release in your learning management system to ensure that students brainstorm each prompt before proceeding to the next video segment for the answer.

References/resources

References for Identity impacts on Active Engagement and Scientific Connection

1. Chen, S., & Wei, B. (2022). Development and Validation of an Instrument to Measure High School Students' Science Identity in Science Learning. Research in Science Education, 52(1), 111-126. https://doi.org/10.1007/s11165-020-09932-y
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5. Sirgy, M. J. (1982). Self-concept in consumer behavior: A critical review. Journal of consumer research, 9(3), 287-300. https://doi.org/10.1086/208924
6. Social Identity Wheel Worksheet Activity: https://sites.lsa.umich.edu/inclusive-teaching/wp-content/uploads/sites/355/2018/12/Social-Identity-Wheel-3-2.pdf

Reference for Course Textbook

7. Kaiser, M. J., Attrill, M. J., Jennings, S., Thomas, D. N., Barnes, D. K. A., Brierley, A. S., Graham, N. A. J., Hiddink, J. G., Howell, K., & Kaartokallio, H. (2020). *Marine Ecology: Processes, Systems, and Impacts*. (3 ed.) Oxford University Press.

Reference for Scientific Paper used in Lesson with Dr. Rachel Leads

8. Leads, R. R., Magnuson, J. T., Lucero, J., Lund, A. K., Schlenk, D., Chavez, J. R., & Roberts, A. P. (2022). Transcriptomic responses and apoptosis in larval red drum (Sciaenops ocellatus) co-exposed to crude oil and ultraviolet (UV) radiation. Marine Pollution Bulletin, 179, 113684.

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Transcript of interview

00:00 – 05:46
Eilea Knotts (EK): Hi, I am Dr. Eilea Knotts, a teaching faculty member at the University of South Carolina in the Department of Biological Sciences. And for this biography interview, I am

talking with Dr. Rachel Leads who is a postdoctoral research associate in the Department of Fisheries and Wildlife at Michigan State University. So, welcome, Dr. Leads.

Rachel Leads (RL): Hi, thank you so much for having me. I am really looking forward to this interview and I'm excited to talk to you about some of the things that are really interesting to me.

EK: Awesome. Well, thank you for talking with me today. Dr. Leads is the first author on a primary literature article titled transcriptomic responses and apoptosis in larval red drum, *Sciaenops ocellatus*, co-exposed to crude oil, and ultraviolet UV radiation, and it's published in the journal marine pollution bulletin.

We're going to start by talking about the paper and the graphs in figure two. So, Dr. Leads, please tell us about this research.

RL: Absolutely. Well, this research stems from my interest and how contaminant toxicity can be influenced by other factors in the environment. So, this type of research adds environmental relevance to standard laboratory toxicity testing, because it incorporates co-occurring stressors that may modify toxicity. So, with this study and follow up studies, we were interested in better understanding the mechanisms of photo induced toxicity and linking molecular and cellular level effects two impacts on higher levels of biological organization, such as metabolism, visual function, and behavior. So, for our study, we specifically looked at the red drum, and red drum are a coastal finfish that are distributed throughout the Gulf of Mexico and the southeastern Atlantic Ocean. And these fish are an economically and ecologically important species in these regions. They also can inhabit areas that can be chronically polluted or impacted by oil spills. Therefore, we selected the species due to their economic importance, environmental relevance, and their potential for oil exposure.

EK: Great. This all sounds like interesting areas of research and explanations of why you focused on the red drum, connecting these molecular and cellular level effects to higher levels of biological and ecological impacts. It's a beautiful demonstration of interconnectedness, even within the sciences. And of course, the best way to view this begins with a figure. So, let's dive into figure two from your paper. Can you please orient us to the figure?

RL: Alright, so, overall, this figure depicts the incidence of apoptotic cell death and fish tissues due to crude oil and ultraviolet radiation exposure. So interestingly, the toxicity of crude oil from oil spills can increase significantly in the presence of UV radiation from sunlight due to a phenomenon called photo-induced toxicity. And photo-induced toxicity occurs when certain wavelengths of light interact with a chemical to increase its toxicity by either modifying its molecular structure or energy state. So, understanding photo induced toxicity is important for evaluating the impacts of oil spills and aquatic ecosystems, because these habitats such as the open ocean can receive really high levels of UV radiation from sunlight. So, to better understand the mechanisms of photo induced toxicity, we tested if exposure to crude oil and the presence and absence of UV would induce or could induce a pathetic cell death. So, apoptosis is defined as programmed cell death, and it is a normal part of physiological function. However, inappropriate timing or levels of apoptosis, which may be induced by environmental stressors or contaminant exposure, can be detrimental to organism how apoptosis can be measured in tissues using fluorescent labeling. With this technique, tissues are stained and visualized using a fluorescent microscope. So, in our experiment, an increase in fluorescence indicated an increase in a pathetic cell death. Therefore, we hypothesize that a pathetic fluorescence would be greatest and fish tissues co exposed to oil and UV due to the potentially eating effects of photo induced toxicity. So back to looking at the figure. In figure two, our treatment group is listed on the x axis as the independent variable. And episodic fluorescence is listed on the y axis as the dependent variable. We quantified episodic fluorescence at two different exposure time points, 24 hours and 48 hours. So, these two time points are separated by the dashed line on the graph. The two treatment groups that we tested were an oil only exposure which here is shown by minus UV plus oil and a UV Oil Co exposure which is shown by plus UV plus oil. And this treatment group is the one that represented photo induced toxicity treatments. We also

compare it to a botanic fluorescence between the inner tissues and the outer tissues of the organisms. The outer tissues such as the skin and eyes are shown in the orange bars, and the inner tissues are shown in the blue bars. The error bars represent standard error of the mean. And lastly, the different letters on the graph indicate statistically significant differences between treatment groups and tissue types.
EK: Interesting. Thanks for walking us through that. I do find that orientation to the figure really helps set up the reader for success to understand your results and conclusions.

05:46 – 06:47
EK: So, with all that said, what were the ultimate conclusions you drew from these results?
RL: From this analysis, we determined that outer tissue layers were more susceptible to apoptotic cell death compared to inner tissue layers in both treatment groups. And this makes sense because the outer tissue layers are in direct contact with the oil and water, and they received the greatest UV exposure. In addition, as predicted, a photonic cell death was greatest following co exposure to crude oil and UV indicating a significant effects of photo induced toxicity. And these data were similar at both 24- and 48-hour exposure time points. So overall, we showed that short term exposure to crude oil can induce apoptotic cell death and fish tissues, and that UV co exposure can significantly increase these adverse effects through photo induced toxicity. And ultimately, these data are important for understanding the mechanisms of photo induced toxicity and the impacts of oil spills using environmentally relevant exposure scenarios.
EK: Exactly.

06:47 – 09:17
EK: Understanding the ultimate impact of these oil spills on organisms not just at the species or populations level, but also at the cellular level is incredibly important. It really goes beyond the desire for basic scientific understanding. This knowledge plays a critical role in conservation and management decisions. So, what follow up experiments did you do next**?**
RL: Exactly, affects at the molecular and cellular levels, such as changes in gene expression or apoptotic cell death may have the potential to impact organism fitness. So, to understand how cell and molecular level effects may impact fitness and ecological performance, it is important to link these sub organism effects and mechanisms to effects on higher levels of biological organization or whole organism endpoints. So, for this reason, we conducted several follow up studies investigating the effects of crude oil photo induced toxicity and fish development, growth, metabolic rate, visual function, prey capture ability and Predator avoidance behavior. So, these are all endpoints that might suggest detrimental effects to ecological performance. And ultimately, it is important to evaluate the effects of contaminant exposure across these multiple levels of biological organization to better understand these potential effects on fitness.
EK: I agree wholeheartedly. Thank you so much for walking us through some of that research. Now, I'd love to ask you a few questions about your experience as a scientist. So, what kinds of scientific questions interests you the most?
RL: Well, as an aquatic toxicologist, I am broadly interested in research questions that investigate the impacts of contaminants on marine and freshwater ecosystems. So, this involves determining the mechanisms and impacts of contaminants on aquatic organisms across multiple levels of biological organization, again, from the molecular and cellular levels to whole organism endpoints. Much of my research involves contaminants of emerging concern. And these are defined as contaminants that are new or previously undetected in the environment, and those for which risks to environmental and human health is not yet fully understood. Lastly, I'm also interested in how other abiotic factors in the environment such as co-occurring chemicals, or climate change effects may influence or modify contaminant toxicity.

EK: Wow. I love that broad range of interests. It sounds like you'll be quite busy conducting all that research. Thank goodness for collaboration.

09:17 – 10:02
EK: So, did you always know that you wanted to be a scientist? Like, when did you realize you had a passion for the scientific world?
RL: Great question. I first knew I wanted to become a scientist back when I was 12 years old, during a family trip to the Pacific Northwest. So, this trip was the first time I had ever seen tide pools and marine mammals. And I really got to experience marine life up close. So, seeing how interested and excited I was in this experience. My mom told me that there are marine biologists who are scientists that study life in the ocean. And from this moment, I knew I wanted to be a marine scientist, and I've been working towards that goal ever since.
EK:
That's really beautiful.

10:02 – 12:23
EK: So, for all those aspiring scientists, that are listening or watching this interview right now, can you walk us through how you got to be where you are now?
RL: Sure. I first received my BA in Biology from Albion College and Albion Michigan. And while at Albion, I also minored in chemistry, I worked as a teaching assistant and the biology department, and I completed a departmental honors research thesis. After I graduated from Albion College, I then spent three years working in scientific outreach and education with several nonprofit educational organizations, and spending some time working in scientific outreach and education really trained me and helped me to become a better teacher and science communicator. During this time, I was also volunteering on research projects with the Belle Isle aquarium and Wayne State University and Detroit, Michigan, just to gain some additional research experience before applying to graduate programs. I then moved to Charleston, South Carolina to complete my master's degree in marine biology from the College of Charleston. And it was during my master's degree that I began to specialize in the field of aquatic toxicology. And I was really drawn to this area of study, because it combined my interest in marine biology, chemistry, environmental science, science, communication and policy. My master's research specifically investigated the occurrence of microplastics in coastal South Carolina, and the toxicity of microplastics to marine invertebrates. I then completed my PhD at the University of North Texas where I studied the impacts of crude oil exposure from oil spills on marine and freshwater fish. And specifically, my doctoral dissertation research investigated how crude oil toxicity can be influenced or modified by other factors in the environment, such as ultraviolet radiation from sunlight. Now at Michigan State University I am studying the effects of per- and polyfluoroalkyl substances, also known as PFAS on fish and the Great Lakes region, and PFAS are a large class of chemicals used in many industrial, commercial and consumer products. And they can enter the environment through many sources, including wastewater treatment, plant effluent or biosolids, industrial manufacturing, and the use of firefighting foams at military bases and airports.
EK: Wow, what a great story. And it's still being written, of course.

12:23 – 13:59
EK: So, what's it been like being a young female scientist?
RL: Well, as an early career scientist and woman in STEM, I do feel very fortunate to have had really positive experiences in graduate school and excellent advisors and mentors. But even with these positive experiences, it can still be easy to feel impostor syndrome and to struggle with perfectionism. And these challenges have caused me to work extremely hard and to make a lot of personal sacrifices just to try to prove myself in this field. So, because of this, I think it's

very important to find positive mentors and a community of other students or collaborators who can provide you with honest feedback, support and encouragement throughout your career trajectory.

EK: I know I asked you this question, as we were starting to develop this collaboration. Was there something specific that you struggled with when figuring out how to answer this question, sharing your personal identities in such a public forum?

RL: Definitely. I wasn't expecting to struggle with answering this question. But it was more difficult than I realized to share these experiences. And I think it's important to acknowledge that fact just in itself, that sharing our beliefs, and our identities and our stories out in public can feel like it runs a risk. But no matter why I do believe and know that representation is incredibly important. And I want to be a part of it. And I'm just so thankful to be here participating in this opportunity.

EK: I completely understand and can relate.

13:59 – 18:53

EK: So, can you share a moment or the moment that you felt like you really belonged or felt as a part of the community of science.

RL: At first, I was really apprehensive about applying to graduate school, I was nervous, I wouldn't be accepted and that I needed additional research experience to be successful. But once I was in graduate school, a turning point for me really was unexpectedly winning my first research presentation award at a national scientific conference. And this experience helped provide me with the confidence and motivation to continue pursuing scientific research. And from this experience, I learned the importance of just having the courage to get started and setting aside fear and doubt, which I know is easier said than done. But now that is my biggest piece of advice, have the courage to get started to try new things and to fully pursue your goals because the outcome can be better and more fulfilling than you ever imagined.

EK: Thank you for sharing that. Having that courage can be really tough. I know self-doubt plagues many of us in the scientific community and just hearing more and more people acknowledge that we have all the same fears helps to really build acceptance. Let's break that stigma that we need to know everything right? Or that we need to be perfect. Science is us floundering around in the unknown trying to further our understanding of nature beyond what we already know. We should feel comfortable sharing our discomfort with each other. And we should be working on building networks to help each other. I love it. So, we are starting to wrap up this interview. So why did you pursue this type of career?

RL: Well, I grew up in Farmington Hills, Michigan, which is a suburb of Detroit. And growing up, I spent a lot of time outdoors and in the water. And like many Michiganders, much of my summers were spent camping, hiking and canoeing or kayaking in northern Michigan. So, growing up in the Great Lakes State definitely shaped my interest in and respect for aquatic ecosystems. However, traveling to different parts of the country, like the Pacific Northwest, really exposed me to new environments, experiences and perspectives, which is what really influenced me to become a scientist. And one of the reasons ultimately, why I love scientific research is because each day can be really different. So, some days involve collecting samples in the field. Other days involve completing experiments in the laboratory, and many days involve analyzing data, preparing presentations, and writing results for publications. So, it really is the best job just because it is so varied.

EK: Yes, exactly. I love it. So, what keeps you motivated them to stay doing this research? I'm sure it can get tiring at times.

RL: Definitely. But maintaining a One Health perspective and aquatic toxicology is what inspires me and motivates me to continue pursuing scientific research in this field. So, the One Health approach is the idea that human health is connected to the health of animals and our shared environment. So, for me, this perspective reinforces the importance of toxicology research, and its implications in ecosystem health, human health and environmental policy. And I find that very inspiring and motivating.

EK: Fantastic, connecting it back to how your research can be applied to better this world. I love it. And it's time for the final question. What is one piece of advice that you would want to share with those listening to or watching this interview?

RL: I just want to reiterate that science is truly a collaborative endeavor. So, I frequently discuss experimental design and data analysis with my advisors, committee members, collaborators and other graduate students. So as a scientist, it is important to remember that you are always learning new information and you are continuously developing and refining your skills.

EK: Beautiful and I couldn't agree more. Being a scientist is a lifelong journey of growth. And we should connect and build community with each other to help further us all along the path of science. With that, I want to thank you very much, Dr. Leads for taking the time to talk about your research and your experiences as a scientist. If you all want to learn more about Dr. Leads work, you can read the paper transcriptomic responses and apoptosis and barcode red drum Sciaenops ocellatus co-exposed to crude oil and ultraviolet UV radiation in the journal marine pollution bulletin in 2022.

RL: Absolutely, I really enjoyed this. And I hope that somebody learned at least a little bit about what it's like to be a scientist and just thank you so much for having me. I'm really grateful for the opportunity and this was so much fun. Thank you so much.

EK: Thank you.

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